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Suzuki

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[54] **TONER SUPPLY DEVICE FOR USE IN IMAGE FORMING APPARATUS**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**[6] **G03G 15/08**

[52] **U.S. Cl.** **399/281**; 395/284

[58] **Field of Search** 399/272, 274, 399/275, 281, 284

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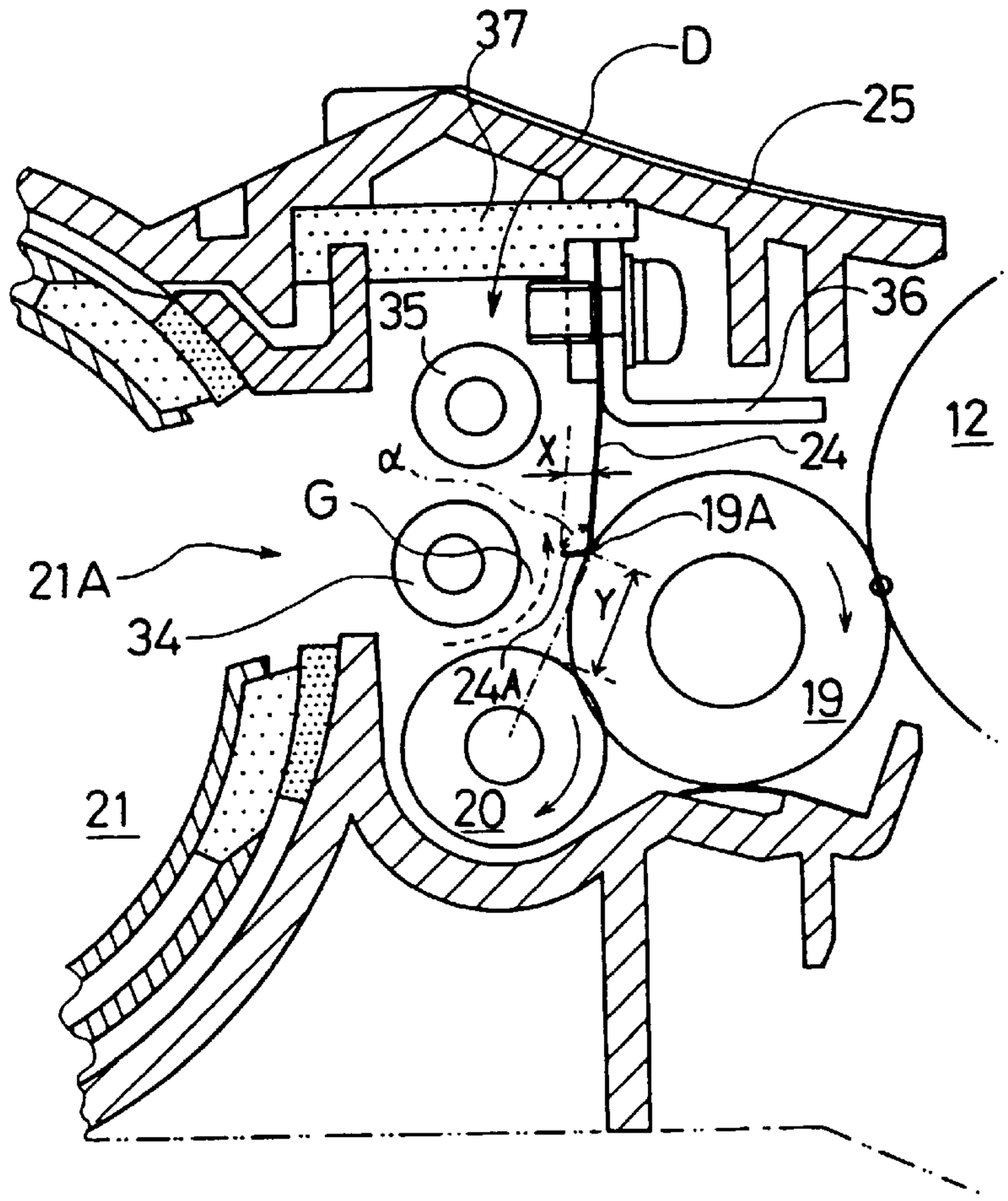
Attorney, Agent, or Firm—Oliff & Berridge, PLC

[57] **ABSTRACT**

A toner supply device for use in an image forming apparatus is constructed such that a length of the extruding portion **24**A of the L-shaped blade **24** is determined to 2 mm or less and a distance of the gap Y is determined to 3 mm or more, the gap Y being formed between the contact portion **19**A and an intersection point where an imaginary straight line passing a rotating center of the toner supply roller **20** and the contact portion **19**A intersects the surface of the toner supply roller **20** namely, between the lower surface of the extruding portion **24**A and the outer peripheral surface of the toner supply roller **20**. With this structure, a toner supply path G is formed linearly around the toner supply roller **20** and the developing roller **19** without making a large detour in the developing roller **19** side, so that the flow of toner can be made smooth in the toner supply path G, preventing toner clogging therein. Accordingly, toner can smoothly be supplied from the toner supply roller **20** to the developing roller **19** and the resultant image excellent in quality can be obtained for a long period.

6 Claims, 6 Drawing Sheets



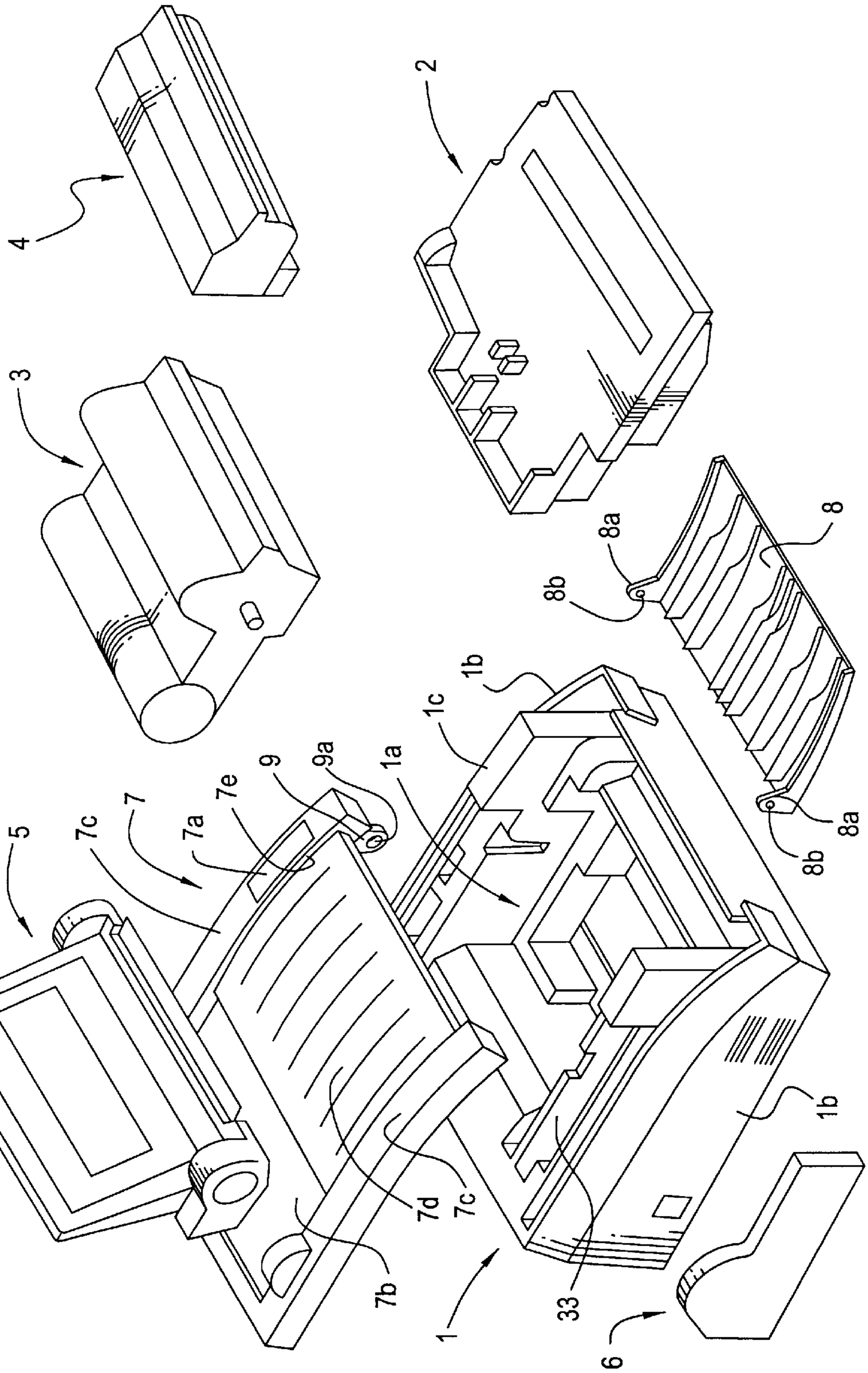
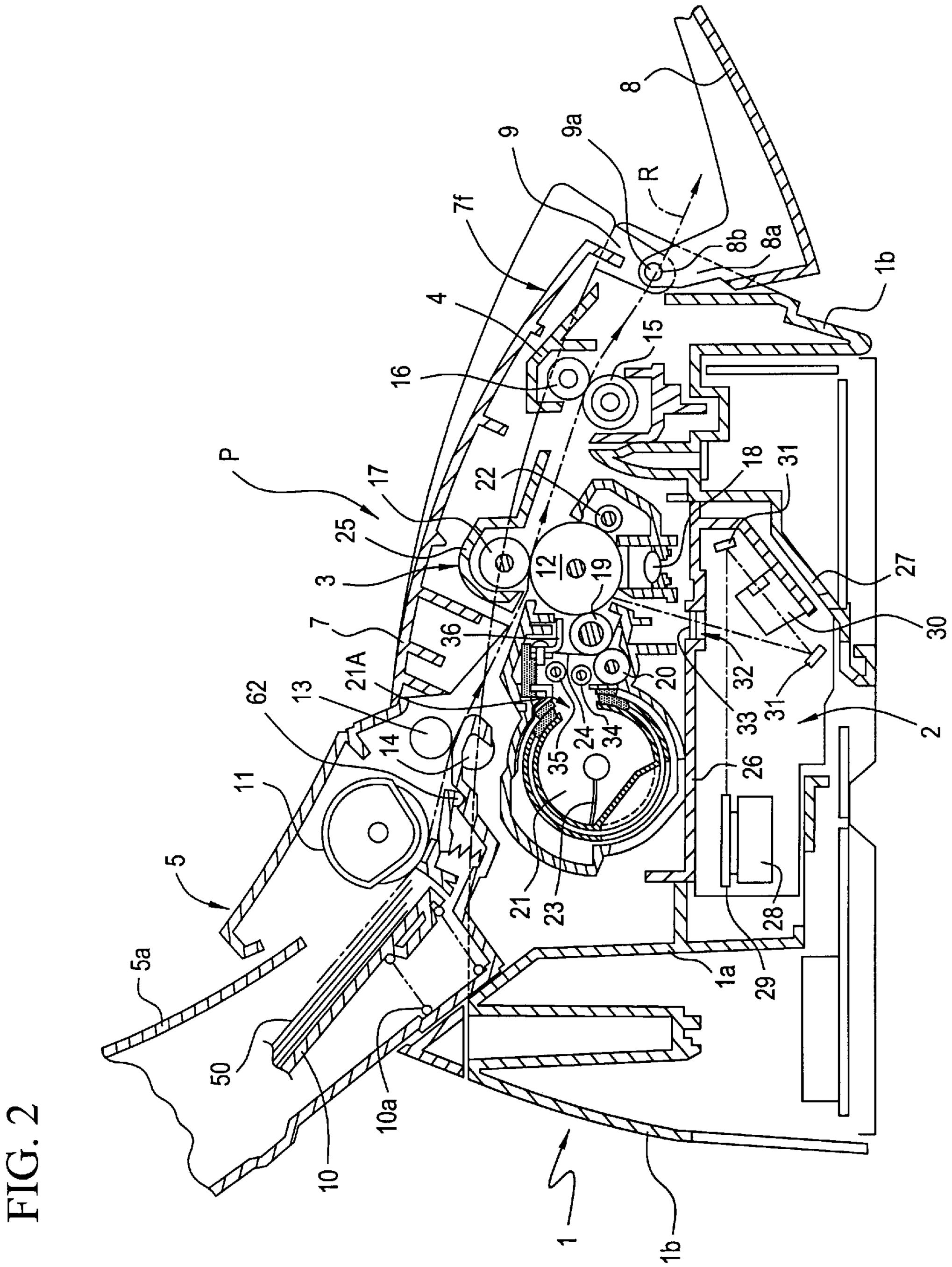


FIG. 1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1b
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3
7
36
30
21A
62
13
20
32
33
31
2
14
24
34
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10a
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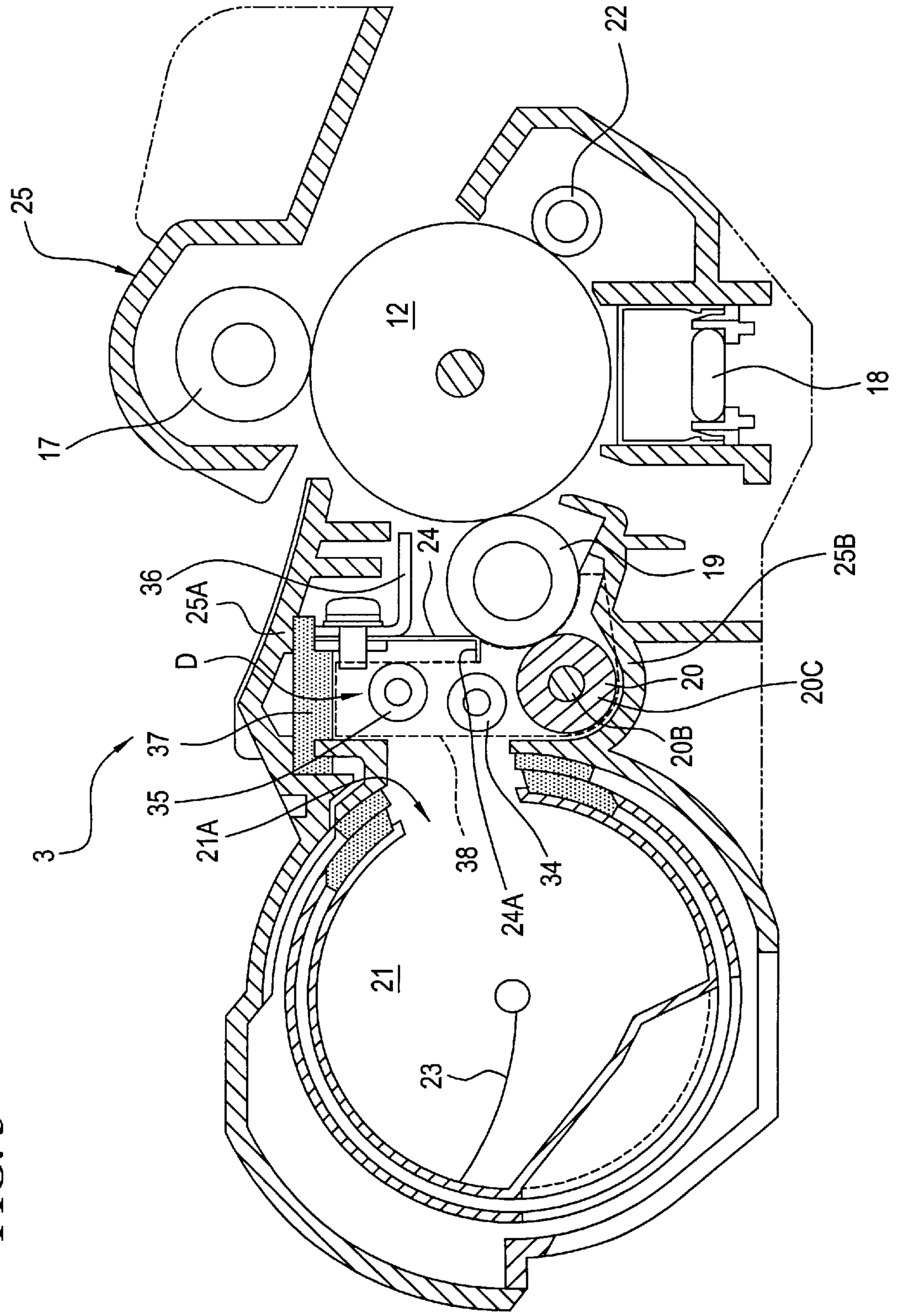
1
1b

FIG. 2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25
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18
17
36
24
25A
19
25B
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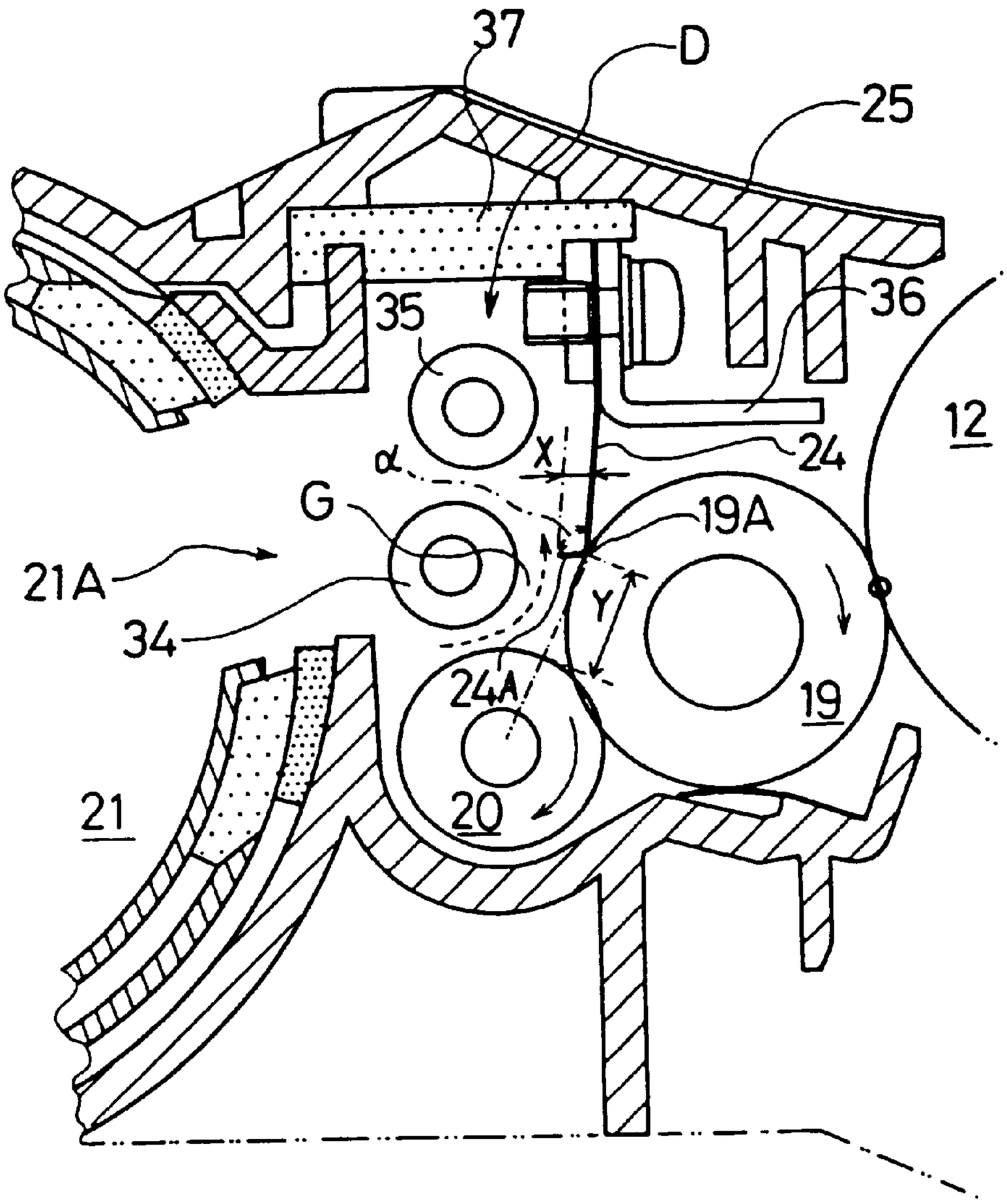
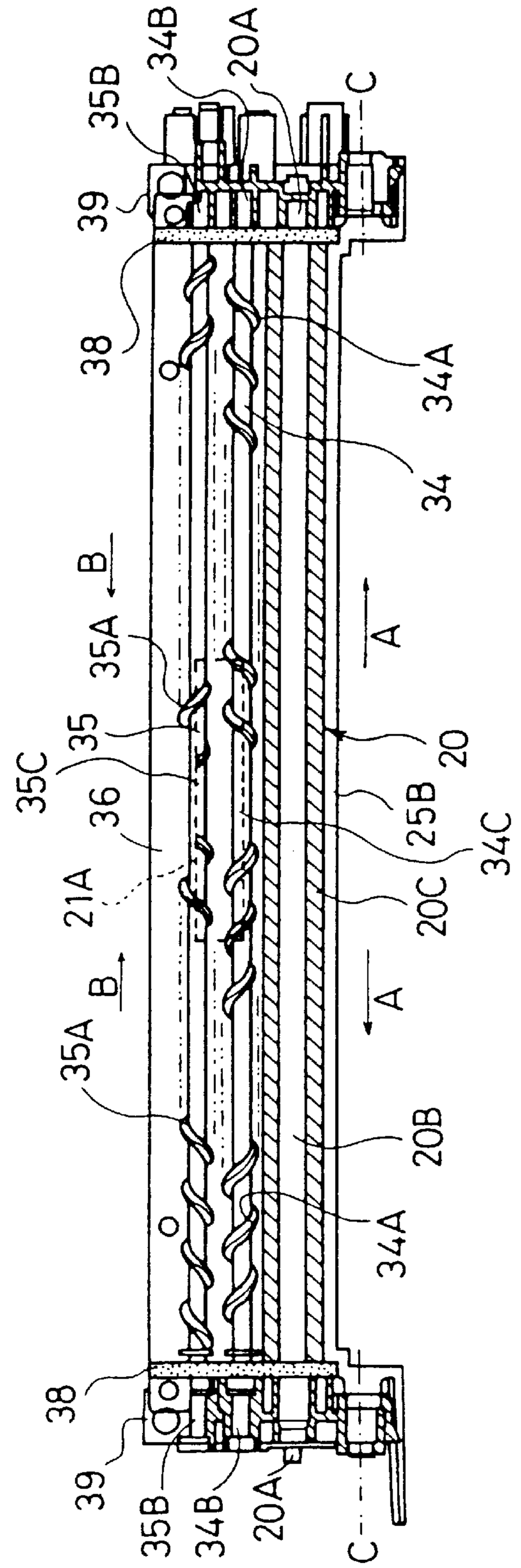
20C
37
20B
35
21A
38
34
3
24A
21
23

FIG. 3

FIG. 4

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35C
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20C
20B
34A
38
39
35B
34B
20A
C

FIG. 5

FIG. 6

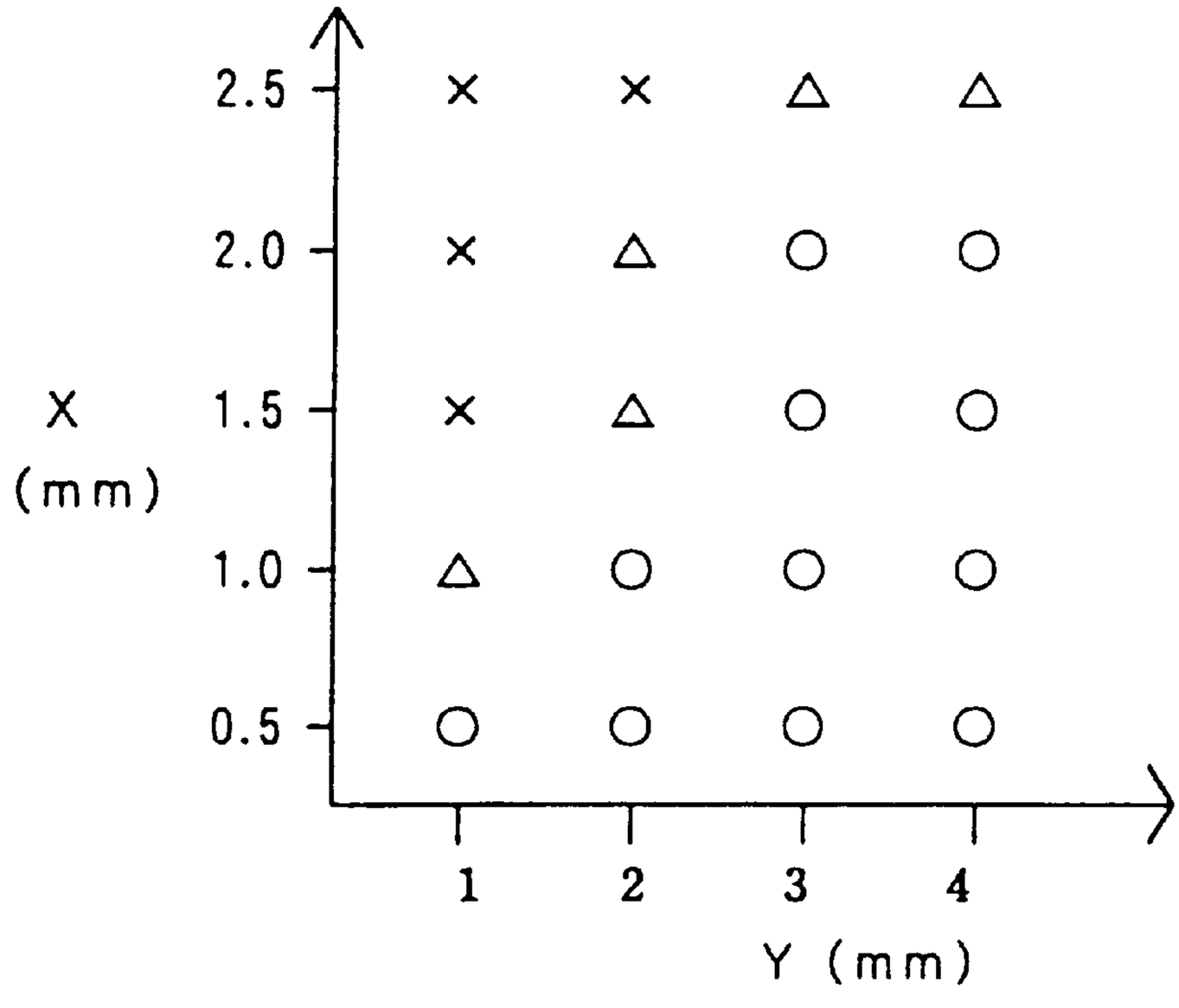
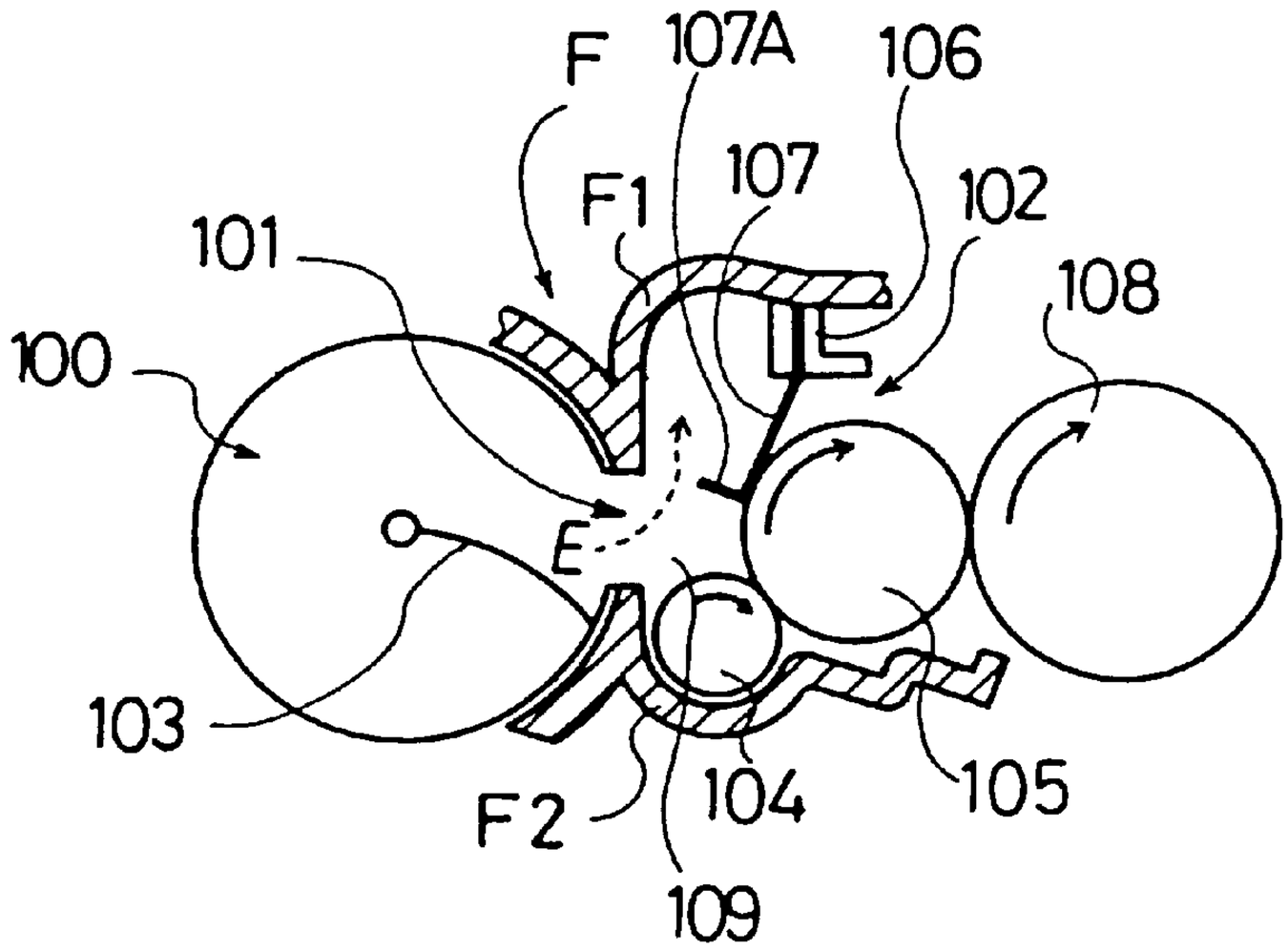


FIG. 7



PRIOR ART

TONER SUPPLY DEVICE FOR USE IN IMAGE FORMING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a toner supply device for use in an image forming apparatus such as a laser printer, etc., for developing an electrostatic latent image by supplying toner to the electrostatic latent image formed on an outer peripheral surface of a photosensitive drum and transferring the image developed on the surface of the photosensitive drum onto a sheet, and particularly to a toner supply device for use in an image forming apparatus, capable of smoothly supplying toner supplied from toner storing part through a toner supply roller to a developing roller without causing clogging with toner in a toner supply path formed around the toner supply roller and the developing roller resulting in obtaining the image with excellent quality for a long period.

2. Description of Related Art

Regarding conventional toner supply devices for use in image forming apparatuses such as laser printers, etc., there have been proposed various types of the devices. In general, such a toner supply device is constructed of a toner storing member including a toner cartridge, a toner supply roller for supplying toner from the toner storing member, and a developing roller for developing an electrostatic latent image on a photosensitive drum by supplying the toner provided from the toner supply roller onto the image. One embodiment of the toner supply device will be explained with reference to FIG. **7**. FIG. **7** is an explanatory view showing schematically a main construction of the toner supply device in the prior art.

In FIG. **7**, the toner supply device has a toner cartridge **100** which accommodates therein toner and is provided with an opening for toner supply at an almost center in its width direction. This toner cartridge **100** is provided therein with an agitator **103** for agitating toner to supply same into a developing chamber **102** side through a toner supply port **101**. A frame F of the developing unit is provided with an opening for toner supply positioned corresponding to the toner supply opening of the toner cartridge **100**. Those openings of the toner cartridge **100** and the frame F form the toner supply port **101** in combination with each other.

Below inside the developing chamber **102** constructed of an upper frame F**1** and a lower frame F**2** of the frame F, a toner supply roller **104** is arranged rotatably in a lower frame F**2** side, for supplying the toner supplied through the toner supply port **101** to a developing roller **105**.

On an internal wall of the upper frame F**1**, above the developing roller **105**, a blade **107** is fixedly secured with a fixing element **106**, whereby regulating a thickness of toner layer formed on the surface of the developing roller **105**. This developing roller **105** is also arranged in contact with a photosensitive drum **108**. On the peripheral surface of the photosensitive drum **108** is formed an electrostatic latent image by an image exposure device not shown which performs a scanning operation with a laser beam in accordance with image data. The developing roller **105** supplies toner on the electrostatic latent image formed on the peripheral surface of the photosensitive drum **108** to develop the image. The image developed on the surface of the photosensitive drum **108** is then transferred onto a sheet fed from a sheet feeder not shown, forming a resultant image (a visual image) on the sheet.

In the toner supply device in the prior art, meanwhile, a toner supply path **109** indicated by an arrow E in FIG. **7** is

formed around the toner supply roller **104** and the developing roller **105**, along which the toner supplied from the toner cartridge **100** through the toner supply port **101** is allowed to flow into the developing chamber **102**. In detail the toner supply path **109** is formed so as to extend from the toner supply port **101**, above the toner supply roller **104**, and make a detour along the lower surface of an extruding portion **107**A of the blade **107**, and finally upward in the developing chamber **102**. The extruding portion **107**A is formed extruding from a contact portion of the blade **107** in contact with an outer surface of the developing roller **105**.

Here, to well supply toner along the toner supply path **109**, it is important to make a determination as to the length of the extruding portion **107**A of the blade **107**, which is the length from the contact portion to the tip end portion of the extruding portion **107**A, and also the gap formed between the lower surface of the extruding portion **107**A and an outer peripheral surface of the toner supply roller **104**. Specifically, if the length of the extruding portion **107**A is too long, it allows the toner supply path **109** to make a detour largely toward the developing roller **105**, preventing a smooth flow of the toner, and thereby causing clogging in the toner supply path **109** with toner. If the gap between the lower surface of the extruding portion **107**A and the toner supply roller **104** is too small, similarly, it prevents the toner from smoothly flowing along the toner supply path **109**, causing clogging therein with toner.

Under such a situation, most of conventional toner supply devices are constructed to have the extruding portion **107**A determined to 2 mm or more in length and the gap determined to 3 mm or less between the lower surface of the extruding portion **107**A and the toner supply roller **104**. Accordingly, it is extremely likely to prevent the toner from smoothly flowing on the toner supply path **109** formed around the toner supply roller **104** and the developing roller **105**, and thereby cause clogging in the toner supply path **109** with the toner. Due to such the toner clogging, it becomes hard to smoothly supply toner from the toner supply roller to the developing roller, which would prevent the forming for a long time of the resulting image excellent in quality.

SUMMARY OF THE INVENTION

The present invention has been made in view of the above circumstances and has an object to overcome the above problems and to provide a toner supply device in claim **1** for use in an image forming apparatus capable of smoothly supplying toner from the toner supply roller to a developing roller without causing toner clogging in a toner supply path formed around a toner supply roller and a developing roller in supplying the toner discharged from a toner storing member of the toner supply device to the developing roller via the toner supply roller, thereby enabling to form for a long period the resulting image with fine quality.

Additional objects and advantages of the invention will be set forth in part in the description which follows and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

To achieve the objects and in accordance with the purpose of the invention, as embodied and broadly described herein, a toner supply device for use in an image forming apparatus of this invention, for developing an electrostatic latent image formed on an outer peripheral surface of a photosensitive drum by supplying toner thereto and transferring the image

developed on the photosensitive drum to a sheet, comprises a toner storing part, a toner supply roller for supplying toner from the toner storing part, a developing roller for supplying toner supplied from the toner supply roller to the electrostatic latent image formed on the photosensitive drum thereby to develop the image, and an L-shaped blade member provided with a contact portion in contact with a surface of the developing roller and an extruding portion formed extruding outward from the contact portion, for regulating a thickness of a toner layer on the developing roller, wherein a length of the extruding portion is determined to 2 mm or less, and a gap formed between the contact portion and an intersection point where an imaginary straight line passing a rotating center of the toner supply roller and the contact portion intersects the surface of the toner supply roller, is determined to 3 mm or more.

According to the above toner supply device in claim **1**, the length of the extruding portion of the L-shaped blade member is determined to 2 mm or less and the gap formed between the contact portion at which the blade member comes into contact with the developing roller and an intersecting point of an imaginary straight line connecting the contact portion and the rotating center of the toner supply roller and intersecting the outer peripheral surface of the toner supply roller, namely, between the lower surface of the extruding portion and the outer peripheral surface of the toner supply roller, is determined to 3 mm or more, so that the toner supply path can be formed linearly around the toner supply roller and the developing roller without making a large detour in the side of the developing roller, enabling a smooth flow of toner in the toner supply path and the prevention of clogging therein. It is therefore possible to supply smoothly toner from the toner supply roller to the developing roller and thereby the resultant image excellent in quality can be obtained for a long period.

The toner supply device in claim **2** of the present invention is characterized in that in the toner supply device in claim **1**, the toner supply roller and the developing roller are driven to rotate in the same direction. In this way, since the toner supply roller and the developing roller are driven to rotate in the same rotating direction, the flow of toner transported along the toner supply path can be made smooth if a difference of rotary speed between the toner supply roller and the developing roller is determined properly.

The toner supply device in claim **3** of the present invention is further characterized in that, in the toner supply device in claim **1**, the length of the extruding portion of the blade member is determined to 1 mm or more to 2 mm or less. The toner supply device in claim **4** of the present invention is characterized in that, in the toner supply device in claim **1**, an angle of the L-shaped portion of said blade member is determined in a range of 90° to 95°.

According to the toner supply device in claim **3** and claim **4**, the toner supply path can be formed more linearly because the angle of the L-shaped portion of the blade member is determined in a range of 90°–95°, so that the toner flow in the toner supply path can be made smoother without toner clogging therein.

The toner supply device in claim **5** is characterized in that, in the toner supply device in claim **1**, it further comprises at least an auger roller arranged near the toner supply roller, the developing roller and the L-shaped blade member, the auger roller forming a toner supply path in cooperation with the toner supply roller, the developing roller and the L-shaped blade member. The toner supply device in claim **6** is further characterized in that, in the toner supply device in claim **5**, the auger roller acts for stirring and dispersing the toner in the toner supply path along a direction of a roller shaft thereof.

According to the toner supply device claimed in claims **5** and **6**, it is arranged in the toner supply device the auger roller which forms the toner supply path in cooperation with the toner supply roller, the developing roller and the L-shaped blade member and acts for stirring and dispersing the toner in the toner supply path along its roller shaft direction. Therefore, it concludes that the toner in the toner supply path is always retained in flowing state. As a result, it can be formed the toner supply path where the toner can smoothly pass through, without disturbance of toner flow.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification illustrate an embodiment of the invention and, together with the description, serve to explain the objects, advantages and principles of the invention.

In the drawings,

FIG. **1** is a perspective exploded view of main components of a laser printer in an embodiment according to the present invention;

FIG. **2** is a sectional side view of the laser printer of FIG. **1**;

FIG. **3** is a sectional side view of a process unit of the laser printer of FIG. **1**;

FIG. **4** is a enlarged view of the developing chamber;

FIG. **5** is a sectional front view showing the internal structure of the developing chamber;

FIG. **6** is a table showing a relation between a length X, a gap Y, and an image quality of the resulting image in variously changing the length X and the gap Y; and

FIG. **7** is an explanatory view schematically showing a main part of a toner supply device in the prior art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A detailed description of a preferred embodiment of a toner supply device for use in an image forming apparatus, specifically in a laser printer, embodying the present invention will now be given referring to the accompanying drawings.

First, schematic construction of a laser printer P in an embodiment will be described with reference to FIGS. **1** and **2**. FIG. **1** is a perspective exploded view of a main construction of the laser printer P. FIG. **2** is a sectional side view of the laser printer P.

In FIG. **1**, a main housing **1** of the laser printer P is formed integrally of a main frame **1***a* and a main cover **1***b* by, for example, an injection molding process. In the main unit **1***a*, set are a scanner unit **2**, a process unit **3**, a fixing unit **4**, and a sheet supply unit **5** from above the main unit **1***a*. The main cover **1***b* serves to cover the outer peripheral four side surfaces, i.e., a fronts back, right, and left sides, of the main frame **1***a*. In a holding recess **33** defined by the outer surface of the main frame **1***a* and inner surface of the main cover **1***b*, a driving system unit **6** including a driving motor and a train of gears is installed and fixed from the lower side of the main housing **1**.

The main frame **1***a* is provided with an operational panel **1***c* formed extruding upward. Both upper surfaces of the main frame **1***a* and the main cover **1***b* are covered with an

upper cover **7**. This upper cover **7** is provided with a hole **7***a* through which the operational panel **1***c* can be inserted and an opening **7***b* through which a base part of the sheet supply unit **5** can be inserted. At both sides in a front side of the upper cover **7** (a right side in FIG. **1**), a pair of brackets **9** each having a support shaft **9***a* extruding opposite to each other (only one of them is shown in FIG. **1**). A sheet discharge tray **8** is provided with support portions **8***a* formed at both sides thereof and bores **8***b* formed in the support portions **8***a*. Each of the bores can be fitted with each support shaft **9***a* of the brackets **9** so that the sheet discharge tray **8** is supported rotatably with respect to the upper cover **7**. On the upper surface of the upper cover **7**, there are provided step portions **7***e* between the upper surfaces of side parts **7***c* and the upper surface of a center part **7***d*. Such the step portions **7***e* form a holding recess **7***f* as shown in FIG. **2** for holding the sheet discharge tray **8** in the center part **7***d* of the upper cover **7** during non-use of the tray **8**. The sheet discharge tray **8** in non-use can be held in the holding recess **7***f* by turning about the support portions **8***a* so as to be held in the upper cover **7** and, to the contrary, it can be set for use at a position to stack sheets discharged from the fixing unit **4** by turning contrariwise from the holding position to a stack position shown in FIG. **2**.

Next, the schematic internal structure of the laser printer P will more detail be explained referring to FIG. **2**. In FIG. **2**, sheets **50** are held as stacked in a feeder case **5***a* of the sheet supply unit **5**. The tip end of each sheet **50** is pressed against a sheet supply roller **11** by a support plate **10** provided with a biasing spring **10***a*, disposed inside the feeder case **5***a*. The sheet supply roller **11** is driven to rotate by a driving power transmitted from the driving system unit **6** and transport individual sheets from the feeder case **5***a* in cooperation with a sheet separating member **62**. The sheet **50** separated from the sheet stack is transported to the process unit **3** by means of a pair of resist rollers **13** and **14**.

The process unit **3** is a unit to perform a toner development of electrostatic latent image by supplying toner to the electrostatic latent image formed on the peripheral surface of the photosensitive drum **12** by means of a laser optical system, which will be mentioned later, provided in the scanner unit **2** in accordance with image data. More specifically, the process unit **3** is constructed of the photosensitive drum **12** a transfer roller **17** disposed above the photosensitive drum **12** and in contact therewith, a charger **18** such as a Scorotron type of charger, disposed under the photosensitive drum **12**, a developing unit including a developing roller **19** disposed upstream of the photosensitive drum **12** in a sheet feeding direction and a toner supply roller **20**, a toner cartridge **21** attachably and detachably disposed upstream of the developing unit, which serves as a toner storing unit, and a cleaning roller **22** disposed downstream of the photosensitive drum **12**, and other components.

Inside of the developing chamber of the developing unit, a pair of auger rollers, namely, a lower auger roller **34** and an upper auger roller **35**, are rotatably provided above the toner supply roller **20**. This lower auger roller **34** functions to transport the toner that is supplied from the toner cartridge **21** via a toner supply port **21**A into the developing chamber, toward both sides of the toner supply roller **20** above the toner supply roller **20**. The toner supply port **21**A is constructed of an opening formed in the toner cartridge at an almost center position thereof and an opening formed in a unit frame **25**. The upper auger roller **35** functions to transport the toner from the both sides of the toner supply roller **20** toward the toner supply port **21**A. In this way, the toner is supplied from the toner supply port **21**A to the developing chamber side by means of the upper and lower auger rollers **35** and **34**, thereby to circulate above the toner supply roller **20** in the both sides thereof. While circulating, the toner is supplied to and stuck on the toner supply roller **20**. The detail structure of each of the lower auger roller **34** and the upper auger roller **35** will be described later.

Above the developing roller **19**, a blade **24** is secured with an L-shaped blade fixing element **36** on the lower surface of the unit frame **25**. The blade **24** serves to regulate the thickness of a layer of toner supplied on the developing roller **19** from the toner supply roller **20** into a predetermined thickness.

The blade **24** is also provided with an extruding portion **24**A formed extruding outward from the contact portion of the blade **24** with the developing roller **19** as shown in FIG. **3**, thereby forming an L-shape.

On the outer peripheral surface of the photosensitive drum **12**, an electrically charged layer is formed by the charger **18** and, then, an electrostatic latent image is formed thereon by scanning with a laser beam by means of the scanner unit **2**. The toner stored in the toner cartridge **21** is stirred by an agitator **23** thereby to discharge the toner through the toner supply port **21**A toward the developing chamber, and is carried on the outer peripheral surface of the developing roller **19** via the toner supply roller **20**, where the toner on the developing roller **19** is regulated to form a toner layer having a predetermined thickness by means of the blade **24**. When the toner is transported from the developing roller **19** to and stuck on the photosensitive drum **12**, the electrostatic latent image formed on the photosensitive drum **12** is visualized and transferred to the sheet **50** passing between the transfer roller **17** and the photosensitive drum **12**. The residual toner remaining on the photosensitive drum **12** is transported to the cleaning roller **22**.

The process unit **3** constructed above is made as a cartridge type by assembling all components into the unit frame **25** formed of synthetic resin. This cartridge-type process unit **3** is detachably and attachably mounted in the main frame **1***a*.

The scanner unit **2** is provided with a well known laser optical system and makes a scanning on the photosensitive drum **12** by the laser optical system in accordance with predetermined image data, thereby forming an electrostatic latent image on the photosensitive drum **12**. More specifically, the scanner unit **2** is arranged under the process unit **3** and a scanner cover **26** is attached on the upper surface of the scanner unit **3**. This scanner cover **26** is fixed at the upstream side of a bottom plate **27** of the main frame **1***a*, covering substantially the whole opening of the main frame **1***a*, and is provided with an oblong scanner hole **32** extending along the axis line of the photosensitive drum **12**. The scanner unit **2** serving as an exposure unit is provided with a laser emitting element **28**, a polygon mirror **29**, a lens **30**, and a reflecting mirror **31**, in which a laser beam can be passed through a glass plate **33** inserted in the oblong scanner hole **32** formed in the scanner cover **26** and emitted to the outer peripheral surface of the photosensitive drum **12** in the process unit **3**. Accordingly, the electrostatic latent image is exposed on the outer peripheral surface of the photosensitive drum **12** in accordance with the image data. To the electrostatic latent image formed on the photosensitive drum **12** by the laser optical system of the scanner unit **2** in the above way, the toner is supplied through the process unit **3**, performing a toner development of the electrostatic latent image.

The toner developed image based on the electrostatic latent image formed on the photosensitive drum **12** in the

process unit **3** is transferred onto the sheet **50** fed to the process unit **3**. After that, the sheet **50** is transported to the fixing unit **4** where the toner image transferred onto the sheet **50** is subjected to a heat fixing process by means of a pair of a heat roller **15** and a pressure roller **16**. The sheet **50** on which a resultant image (a visual image) is formed is then discharged by the rollers **15** and **16** and stacked onto the sheet discharge tray **8** disposed at a stack position. A path along which the sheet **50** is transported from the sheet supply unit **5** to the sheet discharge tray **8** is indicated by a two-dot chain line R in FIG. **2**.

Next, the detail structure of the developing chamber in the process unit **3** will be described with reference to FIG. **3** through FIG. **5** hereinafter. FIG. **3** is a sectional side view of the process unit **3**, FIG. **4** is an enlarged view of the developing chamber, and FIG. **5** is a sectional front view of the internal structure of the developing chamber.

The developing chamber D is a space surrounded by an upper seal member **37** disposed at a lower surface of an upper frame **25**A of the unit frame **25**, a lower frame **25**B of the unit frame **25**, and a pair of side seal members **38** shown in FIG. **5** formed of a sponge material, disposed at both sides inside the developing chamber D. The toner supply roller **20** is constructed of a main shaft **203** provided at its both ends with end shafts **20**A, and a roller member **20**C formed of a sponge material covering the main shaft **203** in its overall length. Each of the end shafts **20**A is inserted in a hole of the side seal member **38** and supported at its outer side with each of a pair of support plates **39** attached rotatably to the lower frame **25**B.

Meanwhile, the detail construction of the blade **24** and the positional relation between the blade **24** and the toner supply roller **20** will be described in reference to FIG. **4**. The structure of the blade is first explained. The length X of the extruding portion **24**A is determined to 2 mm or less, preferably in a range of 1 mm to 2 mm. This length X of the extruding portion **24**A is an important factor to provide an almost linear toner supply path G around the toner supply roller **20** and the developing roller **19** without interrupting the flow of toner. If the length X of the extruding portion **24**A is determined in a range of 1 mm to 2 mm, the toner supply path G is provided in an almost linear path without making a large detour in the developing roller **19** side. This is preferable for manufacturing the blade **24** because it is difficult to manufacture the extruding portion **24**A of 1 mm or less. Angle α between the straight portion of the blade **24** secured by the blade fixing member **36** and the extruding portion **24**A is determined in a range of 90° to 95°. The angle α is an important factor for forming the toner supply path G as well as the length X of the extruding portion **24**A. If the angle a is determined within a range of 90° to 95°, the toner supply path G can be formed as a linear path without preventing the flow of toner.

In addition, a gap Y is formed between the toner supply roller **20** and the blade **24** and it is defined between a contact portion **19**A at which the blade **24** is in contact with the developing roller **19** and a point of intersection of the imaginary straight line connecting the rotating center of the toner supply roller **20** and the contact portion **19**A and intersecting the surface of the toner supply roller, as shown in FIG. **4**. The gap Y thus formed is an important factor for providing the toner supply path G and is determined to 3 mm or more. When the gap Y is determined to 3 mm or more, in combination of the extruding portion **24**A determined in a range of 1 mm to 2 mm, the toner supply path G can be formed more linearly.

The toner supply roller **20** and the developing roller **19** are both driven to rotate clockwise, namely, in the same rotating direction, so that the flow of toner to be transported along the toner supply path G can be made more smoothly if appropriately setting a difference of rotating speed between the toner supply roller **20** and the developing roller **19**.

Meanwhile, the rotating center of each support plate **39** is indicated by a dashed line C in FIG. **5**. Each support plate **39** also supports rotatably the developing roller **19**, so that each support plate **39** is biased in a clockwise direction in FIG. **3** by means of a biasing spring (not shown) to rotate clockwise about the center C, allowing the developing roller **19** to come into contact with the photosensitive drum **12**. With each support plate **39**, the toner supply roller **20**, the upper and lower auger rollers **35** and **34**, and the developing roller **19** are supported integrally, making it possible to easily regulate a positional relation among the above components by handling them as a unit and thus to easily conduct the maintenance thereof.

As shown in FIG. **5**, further, the lower auger roller **34** in which a center portion **34**C thereof is substantially correspondent to a position where the toner supply port **21**A is formed (corresponding to a center portion of the toner supply port **21**A), is provided with spiral teeth **34**A formed spirally extending from the center portion **34**C toward opposite ends of the auger roller **34** on the outer surface thereof. A roller shaft **34**B of the auger roller **34** is supported at both ends with the supporting plates **39** as well as the toner supply roller **20**. When the lower auger roller **34** is rotated clockwise in FIG. **3**, accordingly, the toner supplied from the toner supply port **21**A is transported successively along the spiral teeth **34**A above the toner supply roller **20** toward both ends of the developing chamber D in opposite directions indicated by arrows A. Similarly, a center portion **35**C of the upper auger roller **35** is substantially correspondent to a position where the toner supply port **21**A is formed (corresponding to a center portion of the toner supply port **21**A). The upper auger roller **35** is provided with spiral teeth **35** formed spirally extending from both ends of the auger roller **35** toward the center portion **35**C. A roller shaft **35**B of the auger roller **35** is supported with the supporting shaft **39** as well as the upper auger roller **34**. When the upper auger roller **35** is rotated clockwise in FIG. **3** and the toner transported by the lower auger roller **34** toward the both ends of the developing chamber D is so increased to reach the upper auger roller **35**, the toner is transported successively along the spiral teeth **35**A in directions indicated by arrows B toward the toner supply port **21**A. Thus, a part of the toner is return to the toner cartridge **21** through the toner supply port **21**A. In this way, the toner not used for image development is circulated as above and returned to the toner cartridge **21**, so that it can prevent toner from remaining in the developing chamber D for a long time. This makes it possible to supply constantly fresh toner from the toner cartridge **21**. Even if the toner is not returned to the toner cartridge **21**, stirring and circulating by the upper and lower auger rollers **35** and **34** makes toner smoothly flow in the developing chamber D without causing agglomeration of toner.

As mentioned above, each of the upper and lower auger rollers **35** and **34** serves to transport and circulate the toner supplied from the toner supply port **21**A into the developing chamber D, above the toner supply roller **20**, thereby enabling uniform sticking of toner to all the toner supply roller **20** over without allowing the toner to remain in a limited part. As toner is transported and circulated above the toner supply roller **20** and in its both side directions by means of the upper and lower auger rollers **35** and **34**, constantly fresh toner can be stuck on all over the toner

supply roller **20**, making it possible to supply uniformly toner to the developing roller **19** and the electrostatic latent image formed on the outer peripheral surface of the photosensitive drum **12**, thereby to form for a long time the resultant image excellent in quality.

As above, the forming position of the toner supply port **21**A in the toner cartridge **21** (a center position of the toner supply port **21**A) substantially coincides with the center positions **35**C and **34**C of the upper and lower auger rollers **35** and **34**, so that the toner discharged through the toner supply port **21**A can efficiently be transported and circulated above the toner supply roller **20** via the upper and lower auger rollers **35** and **34**.

Next, referring to FIG. **6**, explained is the influence by variations of the length X and the gap Y on the quality of resultant image in the case that an image forming operation is performed using the toner supply device constructed above while changing the length X of the extruding portion **24**A of the blade **24** and the gap Y formed between the lower surface of the extruding portion **24**A and the outer surface of the toner supply roller **20**. FIG. **6** is a table showing the relation between the length X, the gap Y, and the quality of resultant image in the case that the length X and the gap Y are variously changed where the horizontal axis represents a gap Y (unit: mm) and the vertical axis represents a length X (unit: mm) respectively In the table, "○" means that the resultant image with high quality was obtained without occurring toner clogging in the toner supply path G even after the image forming operation on 10000 or more sheets, "Δ" means that the resultant image deteriorated in quality after the image forming operation on several thousand of sheets though toner clogging has not occurred, and "X" means that toner clogging occurred at an early stage of the image forming operation.

As clearly from FIG. **6**, when the gap was 1 mm, there was no toner clogging and deterioration of the quality of resultant image if the length X was 0.5 mm, on the other hand, the quality of resultant image deteriorated although there was no toner clogging if the length X was 1.0 mm. When the length X was 1.5 mm or more, it is found that there occurred toner clogging and deterioration in quality of resultant image. When the gap Y was 2 mm, toner clogging and deterioration in image quality did not occur if the length X of the extruding portion **24**A was 1.0 mm or less; however, when the length X was in a range of 1.5 to 2.0 mm, the quality of resultant image deteriorated although no clogging with toner occurred. It is still found that toner clogging and image quality deterioration occurred when the length X is 2.5 mm or more. In the cases that the gap Y was 3 mm and 4 mm, no toner clogging and deterioration in image quality occurred if the length X of the extruding portion **24**A was 2.0 mm or less; however, the quality of resultant image deteriorated although no toner clogging occurred if the length X was 2.5 mm or more.

As clearly from above, it is difficult to manufacture the blade **24** with the extruding portion **24**A having a length X of 1.0 mm or less, the gap Y is preferably determined to 3 mm or more in consideration of that the length X of the extruding portion **24**A is suitably determined in a range of 1 mm to 2 mm.

In the toner supply device in the above embodiment, the length of the extruding portion **24**A of the L-shaped blade **24** is determined to 2 mm or less and the distance of the gap Y is determined to 3 mm or more, the gap Y being formed between the contact portion **19**A and the intersecting point of the imaginary straight line connecting the rotating center of the toner supply roller **20** and the contact portion **19**A at which the blade **24** is in contact with the developing roller **19**, intersecting the outer surface of the toner supply roller **20**, in other words, between the lower surface of the extruding portion **24**A and the outer surface of the toner supply roller **20**, so that the toner supply path G provided around the toner supply roller **20** and the developing roller **19** can be formed linearly without making a large detour toward the side of the developing roller **19**, thereby allowing the toner to smoothly flow in the toner supply path G and thus preventing the toner supply path G from being clogged with toner. It is therefore possible to supply toner smoothly from the toner supply roller **20** to the developing roller **19** and to form for a long period the resultant image good in quality.

Since both the toner supply roller **20** and the developing roller **19** are driven to rotate in the same direction (in a clockwise direction), a smoother flow of toner along the toner supply path G can be obtained if a difference of rotating speed between the toner supply roller **20** and the developing roller **19** is properly determined.

Further, in the above embodiment, the extruding portion **24**A of the blade **24** is determined in a range of 1 mm to 2 mm and the angle α of the extruding portion **24**A of the blade **24** is determined in a range of 90° to 95°, that the toner supply path G can be formed linearly, making it possible to make the flow of toner smooth and to prevent clogging in the toner supply path G with toner.

The foregoing description of the preferred embodiments of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention. The embodiment chosen and described in order to explain the principles of the invention and its practical application to enable one skilled in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto, and their equivalents.

What is claimed is:

1. A toner supply device for use in an image forming apparatus for developing an electrostatic latent image formed on an outer peripheral surface of a photosensitive drum by supplying toner thereto and transferring the image developed on the photosensitive drum to a sheet, comprising a toner storing part, a toner supply roller for supplying toner from the toner storing part, a developing roller for supplying toner supplied from the toner supply roller to the electrostatic latent image formed on the photosensitive drum thereby to develop the image, and an L-shaped blade member provided with a contact portion in contact with a surface of the developing roller and an extruding portion formed extruding outward from the contact portion, for regulating a thickness of a toner layer on the developing roller;

wherein a length of said extruding portion is determined to 2 mm or less, and a gap formed between said contact portion and an intersection point where an imaginary straight line passing a rotating center of the toner supply roller and the contact portion intersects the surface of the toner supply roller, is 3 mm to 4 mm.

2. A toner supply device for use in an image forming apparatus according to claim **1**, wherein said toner supply roller and said developing roller are driven to rotate in the same direction.

3. A toner supply device for use in an image forming apparatus according to claim **1**, wherein the length of the

extruding portion of the blade member is determined to 1 mm or more to 2 mm or less.

4. A toner supply device for use in an image forming apparatus according to claim **1**, wherein an angle of the L-shaped portion of said blade member is determined in a range of 90° to 95°.

5. A toner supply device for use in an image forming apparatus according to claim **1**, further comprising at least an auger roller arranged near the toner supply roller, the developing roller and the L-shaped blade member, the auger roller forming a toner supply path in cooperation with the toner supply roller, the developing roller and the L-shaped blade member.

6. A toner supply device for use in an image forming apparatus according to claim **5**, wherein the auger roller acts for stirring and dispersing the toner in the toner supply path along a direction of a roller shaft thereof.

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